ECG091

Energy Benchmarks and Saving Measures for Protected Greenhouse Horticulture in the UK

CARBON TRUST

Making business sense of climate change

Contents

1 Introduction

1.1 Background to greenhouse energy use

The successful growing of a protected horticultural crop is dependent upon optimising the biological processes associated with crop development. Whilst energy can be saved by simple actions such as reducing heating temperatures, lighting levels or CO_2 concentrations, it is unlikely that this approach will give results that are economically acceptable as it may well compromise plant performance. To reduce energy use, the main strategy must to be to identify areas of energy waste and eliminate them.

2 Background to this Guide

This guide presents benchmark data on 'best practice' levels of energy consumption for greenhouses in the UK.

Benchmarks are valuable because they allow growers to compare the performance of their operation with other similar businesses. In addition, they also provide two other useful functions:

- They allow routine assessments to be made that show progress against a benchmark. Such appraisals are not restricted to year-on-year evaluations as they can be carried out quarterly, monthly or even weekly to track progress on a more regular basis
- They allow the effect of opportunity assessments to be quantified. For example, if a facility is to be modified or upgraded, the effect of the change can be determined.

Throughout this guide, the benchmarks and information are based on methods and techniques that minimise energy consumption whilst maintaining crop performance at an economically acceptable level.

Protected horticulture in the UK is a complex and diverse industry with many types of crop being produced in a wide range of facilities. To produce guidelines for all of the crop and production system combinations would be an extremely time consuming and difficult task. Therefore, in order to give realistic guidelines, a small number of key crops have been chosen to illustrate typical performance benchmarks for growers in the UK. These key crops/production methods are:

1. **Energy intensive edible crop production** - e.g. tomatoes, cucumbers and peppers using high temperatures (above 18°C) together with humidity and CO_2 control
2. **Energy intensive ornamental crop production** - e.g. chrysanthemum, begonia and poinsettia using temperatures above 18°C together with humidity control, CO_2 enrichment and supplementary lighting
3. **Energy extensive edible crop production** - e.g. lettuce production where lower growing temperatures and less complex environmental controls are used
4. **Energy extensive ornamental crop production** - including crops that are grown at low temperatures (<15°C heating temperature) such as bedding plants etc.

In all cases, the benchmark information has been cross-referenced to similar information from Holland. The Dutch publish a comprehensive range of energy targets for the period 2000 to 2010. Individual figures are produced for all of the major crops. This data is particularly useful because the growing systems they use are comparable to the ones employed by UK growers. Also, Dutch weather conditions are very similar to those experienced in the UK. All of the Dutch targets are published in the 'Handboek Milieumaatregelen Glastuinbouw' and example figures for key UK crops are given in Appendix one of this booklet.

3 Measuring energy efficiency

Energy use benchmarks relate energy use to cropped area or production output. In this way, businesses of dissimilar size or output can easily be compared. (See Table 1 in Section 6 for benchmark values).

Energy benchmarks are therefore a measure of energy use intensity and the most common units are energy use per unit area (kWh/m^2) and energy use per unit yield (e.g. kWh/kg).

3.1 Energy/m²

This is calculated by dividing the total energy input for the operation by the heated area. When carrying out this calculation, it is important that all fuel inputs are converted to a common energy unit (i.e. kWh). This involves applying appropriate conversion factors, which are given in Table 3, Appendix one.

Measuring energy efficiency based on area is easy to understand and the data allows the relative performance of different sites to be easily compared. For this reason, all of the information given in this guide is quoted in units of kWh/m^2.

This measure of efficiency has one main shortcoming in that it does not take into account any improvement in plant productivity. So for instance, if a glasshouse produces 10% extra crop for the same energy input, this is not recognised as an improvement in energy efficiency.

3.2 Energy/yield

Energy/yield is calculated by dividing the total energy input by production. As with energy/m^2 all energy inputs must be converted to a common basis (e.g. kWh).

This circumvents the shortcoming of area based efficiency measures as it recognises the role of yield increases in energy efficiency. Comparison of performance between sites can be more difficult, however, as production output is measured in so many different ways.

Yield based measurements can work well for edible crops such as tomato, cucumber and pepper as the yield of these products is commonly measured by weight. In this case, energy intensity is expressed in kWh/kg. Variety changes can make the measure difficult to apply, as yield may be very different between one variety and the next.

Applying a yield based system is particularly complex in the ornamentals sector as the method of production measurement changes from crop to crop. For example, cut flower chrysanthemums are measured in numbers of stems whereas pot chrysanthemums are counted in numbers of pots. Furthermore, young plants may be measured in numbers of trays and bedding plants in numbers of packs. All of these various measures of output make this system very difficult to apply in practice especially where there is a mix of products on a site.

4 Establishing the facts and planning actions

4.1 Taking stock of the current situation

Before a business can make use of energy use benchmarks, it must carry out a simple assessment to establish energy use. This involves collecting information on the amount of energy used and calculating the energy intensity. This is done by gathering information of the total energy use for the previous year and dividing it by the total greenhouse heated area to calculate the intensity in kWh/m^2. (See Table 1 in Section 6 for benchmark values).

4.2 Comparing performance

Once the energy intensity has been calculated, performance can be compared with the appropriate benchmark. Having done this comparison, you may wish to take one of the following courses of action:

- If the figure is more than **typical**, urgent action is required to reduce energy consumption. Some measures are suggested in Section 5
- If the figure is between **typical** and **good practice** then action is still needed to improve performance
- Even if performance is in line with **good practice**, there is still scope for improvement although the need to make changes is less urgent.

4.3 Identifying energy efficiency measures

Section 5 contains information on measures that can be used to make energy efficiency improvements. These methods can be used on an existing greenhouse or at the design stage for new or refurbished facilities.

The savings figures quoted can be applied to the calculated energy intensity to determine the likely effectiveness of using the techniques described.

Note: the Carbon Trust is continually seeking new and credible data describing the energy performance of greenhouses. If you have information that you consider may be applicable, particularly for additional crops or facilities that are more efficient than the good practice figures given here, then please contact the Carbon Trust.

5 Energy saving measures

5.1 Energy management approach

Establishing an energy action plan is the essential foundation for the reduction of energy waste in any horticultural business. This action plan should consider all of the information available to the company and should have the backing of senior management.

GPG323: 'Energy saving guide for agriculture and horticulture' gives detailed information on how to set up an energy action plan.

5.2 High priority/low cost measures

In general, it is best initially to implement no-cost and low-cost measures which require little or no capital expenditure. In many cases, these measures give the best rewards as significant savings can often be made quickly and for little effort and expenditure.

Examples of low cost actions are as follows:

5.2.1 Monitor energy use

This is the basis of good energy management. Without detailed energy use data, it is impossible to get a complete and accurate picture of how energy is used in the business.

Do not rely on utility bills alone as these can often be based on irregular or estimated meter readings. Take regular manual meter readings and record these in systematic manner. If you are billed on a monthly basis then take readings at least weekly, likewise if you are billed quarterly, then take readings at least monthly. Make meter reading habitual if possible. This way you can be sure that you are getting regular and accurate information. Relate the information collected to production levels and external influences like the weather. (See 'The Calculation of Glasshouse Fuel Requirements Using Degree Day Data Corrected for Solar Gain'[1], for more information. Tracking progress in this way will give an early warning of any unexpected changes in consumption.

5.2.2 Carry out maintenance and repairs

Simple repairs are often overlooked but they are an essential part of reducing wasted energy. Glass cleaning, replacing broken glazing and repairing damaged insulation are good examples of areas that are often neglected. As an example, a 1m length of uninsulated 100mm-diameter pipe carrying water at 80°C can waste 200kWh of heating fuel a week.

5.2.3 Review greenhouse utilisation

It may sound obvious but heating a greenhouse that is empty or only partly utilised is one of the biggest areas of energy waste. Review how cropping is organised in the greenhouse and try to increase the utilisation of any heated areas.

5.2.4 Check the accuracy of controls

Temperature sensors should be checked for accuracy on a regular basis. Use a reference thermometer to check readings taken by the climate control equipment and when inaccuracies are found, take immediate action.

It is also worth doing a survey of the temperature distribution within the greenhouse. Temperature can vary both in the horizontal and vertical planes. If you are controlling temperature based on the coldest area then other areas will be above optimum temperature and energy waste will occur. Appropriate measures including repositioning of sensors or using air circulation fans can reduce energy consumption.

Circulation fans can be used to achieve a consistent environment with minimised energy inputs

[1] Horticultural Development Council (HDC), Bradbourne House, East Malling, Kent ME19 6DZ. 2002.

5.2.5 Construct and use graphs from your climate computer

If you have a climate computer then use graphs to track the effectiveness of climate control settings. Often energy is wasted due to inappropriate settings. Rapid changes in the environment indicate that all is not well and that settings need to be reviewed.

5.3 Medium and long term actions

Having considered and implemented all the low-cost and no-cost measures, the next stage is to determine the relevance of energy saving measures that may require capital expenditure. In these circumstances, careful planning and consideration is required to ensure that such an approach is economically viable and the best approach to energy saving performance is being taken.

The following sections give brief descriptions of the technologies that may be used by a grower to reduce energy consumption. Additional information relating to the range of energy savings expected from each approach is also given in Table 2 (Section 6).

5.3.1 Greenhouse structures

Improvements to the greenhouse structure often present the biggest opportunity to save energy. By reducing air leakage from the structure, a 10-30% wintertime fuel saving can be made. Windy weather greatly increases heat loss so attention to draught proofing and air leaks is very important. If the air change rate changes from, say, 0.5 to 5 changes per hour, the glasshouse heat loss can increase by as much as 45%.

Recent advances in greenhouse design and construction have significantly improved energy performance. Better construction methods and improvement in the quality of the doors and ventilators have all improved the air-tightness of structures. New designs of greenhouse will therefore have a better energy performance than older styles.

For existing glasshouses, simple structural improvements can improve energy efficiency. All openings to the glasshouse should be inspected to check that they make a good seal when closed and all cracked, broken or displaced glass should be replaced. Glass to glass joints should be sealed with clear silicone sealant. Such measures will reduce the number of air changes dramatically and this will be reflected in savings in heating costs.

Traffic in and out of the glasshouse should be minimised and personnel instructed to keep access doors closed. Main access points may benefit from automatic doors, making access easier / faster while ensuring that they are closed whenever possible.

5.3.2 Thermal screens

Thermal screens are an effective method of reducing the heat loss from a greenhouse. Following a significant amount of recent research and development, new designs optimise energy retention whilst minimising light attenuation. New materials that pack very tightly when retracted will minimise the light interruption from the screen and closing mechanism. Materials are also closely matched to the needs of specific crops and greenhouse types.

Modern designs of thermal screen can save energy without reducing crop yield

Screens largely fall into two main categories:

5.3.2.1 Fixed screens

Fixed screens are put in place above the crop for several weeks and then completely removed. This period coincides with the coldest months of the year (typically Dec, Jan or Feb) and the period when crops are in the early stages of development. The most common material used for construction of a temporary screen is perforated polythene sheeting.

The screen is usually removed at the time when light transmission to the crop becomes a high priority and the crop has developed to such a point that the humidity levels below the screen become excessive.

5.3.2.2 Movable screens

Movable screens give better general performance than fixed screens. They can be opened and closed

as necessary enabling the best use of available light and better control of humidity.

Constructed from fabric or polymer based materials, movable screens are tailored to the crop requirements. They may include special moisture transmission characteristics (for humidity control) and summer shading.

Recent developments have included materials and actuating mechanisms that cut down light interruption to less than 1%, thereby minimising the potential for yield loss.

5.3.3 Heating equipment

Heating equipment in greenhouses can range from simple direct acting space heaters through to boilers with distributed pipe systems. In all cases, efficiency of the heating equipment has an important role to play in reducing wasted energy. Regular maintenance is a key consideration with all types of heaters.

Recent developments have significantly increased the efficiency of boiler equipment.

A well maintained boiler is the heart of an efficient heating system

Additionally, condensers can be used to recover heat from the flue gases and further increase efficiency. Condensers are an essential piece of equipment where CO_2 is being recovered from boiler flue gases for enrichment purposes. The two main types of condenser are as follows:

5.3.3.1 Single stage condenser

This design cools the boiler flue gases to the point of condensation, thus releasing latent heat. This energy is then used in the greenhouse either by pre-heating the boiler return water or by heating a separate low temperature heating loop.

5.3.3.2 Two stage condenser

This design uses two sections to further increase the amount of recovered energy. The first stage is connected to the boiler return line whilst the second is connected to a separate low temperature heating loop.

5.3.4 CO_2 enrichment and heat storage

5.3.4.1 Enrichment

CO_2 enrichment has become an essential tool in the production of many greenhouse crops. Whilst it does not reduce energy consumption, it increases crop yield. Therefore when viewed on an output basis, the energy efficiency of production can be significantly improved.

CO_2 is commonly generated by burning fuels such as gas, Liquid Petroleum Gas (LPG) or Kerosene. Growers sometimes think that using this approach produces 'free' CO_2. This is only the case if all of the heat produced during the combustion process is put to good use and is not vented to atmosphere by the greenhouse ventilation system.

5.3.4.2 Heat buffer tanks

Heat buffers are used to store heat from the boiler during CO_2 enrichment when there is little or no demand for heat in the greenhouse. They allow the heat produced during combustion to be stored for use at a later time. This often coincides with the overnight period when heat demand may be high but there is no demand for CO_2.

Correctly sized heat storage tanks can optimise energy inputs and the availability of CO_2 for atmospheric enrichment

For best energy efficiency, it is important that buffer tanks are adequately sized and well insulated. Current insulation recommendations are for a minimum of 50mm thick material to be provided over the complete system. It is also important that the insulation material is weatherproof. If this is not the case then heat will be wasted due to either heat losses from the tank or an inability to store all of the hot water generated. Recent Horticultural Development Council funded work carried out by Silsoe Research Institute has produced a spreadsheet-based calculator to help growers determine the best economic strategies for CO_2 enrichment[2]. It is recommended that growers should use this tool.

5.3.5 Combined heat and power (CHP)

Because of their high heat demands, greenhouses are generally considered to be a good application for the use of CHP. In addition, it is often possible to recover CO_2 from the CHP exhaust gases, thus allowing CO_2 enrichment to be carried out direct from the CHP. With a reciprocating engine, CHP flue gas cleaning is required to remove potential pollutants from the exhaust gas but this is not necessary for machines based on gas turbines

CHP units should be used in conjunction with boiler equipment so the CHP satisfies the 'base load' heating requirement whilst the boiler is used to satisfy any peaks that may occur through the year.

For CHP to be economical, the electricity that is generated must find a use on site or be 'exported'. Typically there are two operational scenarios:

5.3.5.1 Electricity export

Here, the CHP unit is sized to meet the heat and/or CO_2 demands of the greenhouse. This will normally result in a surplus in electricity generation as the on-site load is likely to be comparatively small. This presents an opportunity for electricity to be exported via the network to other consumers. A contract with a wholesale electricity buyer needs to be put in place to facilitate this. In addition, the small amount of electricity used locally on the nursery can be supplied from the CHP.

It should be noted that the gross amount of energy consumed by the nursery might increase when CHP is installed in this configuration. This is because the thermal efficiency of the CHP is lower than the thermal efficiency of an equivalent boiler. Therefore, when the unit is sized to match heat demands, the total amount of heating fuel (i.e. gas) is likely to increase. When assessing the energy efficiency of the site, the exported electricity must be taken into account so that some credit is obtained for this component of the CHP output.

5.3.5.2 Electricity use on site

In this case, all of the energy generated by the CHP (heat and electricity) is used on the host site. Heat and CO_2 are used as described above whilst the electricity is used to satisfy the demands of the site. In greenhouse horticulture, the most obvious application is when crops are grown using supplementary lighting. Here, the simultaneous demand for heat, light and CO_2 are all satisfied from the CHP and extended periods of crop production can be undertaken with little or no electricity taken from mains sources.

Again, installing a CHP may increase the total gas consumption of the site as highlighted above, however, the overall efficiency of energy use should increase because no electricity is imported onto the site.

Supplementary lighting is an effective way of optimising plant performance at times of low natural radiation

[2] 'Tomatoes: Guidelines for CO_2 Enrichment – A Grower Guide', Horticultural Development Council, Bradbourne House, East Malling, Kent ME19 6DZ, 2002.

5.3.6 Greenhouse controls

The control of greenhouse heating, ventilating and atmosphere modification equipment must be as accurate as possible. Modern equipment is sophisticated, reliable and gives the grower a wide range of options for managing energy use in the greenhouse.

Recent developments have highlighted a number of areas where advanced control strategies can help the grower make energy efficiency improvements.

Temperature and humidity measurement equipment must be regularly checked and maintained

5.3.6.1 Temperature integration (TI)

TI uses the ability of plants to respond to an average temperature rather than an absolute set point. The average greenhouse temperature is managed over a given 'integration' period (typically between one and seven days) and is dependent on the crop being grown.

Permitting the greenhouse temperature to deviate from the desired average value saves energy (as long as this is subsequently compensated for). For example, allowing greenhouse temperature to rise during the day when solar gain is high allows a reciprocal lowering of the temperature during the following night.

Recent research has shown that TI can produce reliable energy savings of around 10% on a wide range of crops with no effect on crop quality or scheduling.

5.3.6.2 Reduced minimum heating pipe temperatures

Many growers use a minimum heating pipe temperature setting to help to minimise humidity problems and activate the crop. Recent work has shown that this process can be ineffective and wastes energy.

In many cases, the minimum pipe setting only serves to increase the greenhouse temperature, thereby resulting in the need to ventilate to control temperature. More considered use of minimum pipe settings can save energy without compromising crop performance.

5.3.6.3 Humidity control strategies

The combined use of heating and ventilation is used to control greenhouse humidity within pre-determined levels. The method most commonly used in practice is to apply heat once the humidity in the greenhouse starts to rise above the desired level. This heating increases both the internal temperature and more importantly, the moisture holding capacity of the air. Once the temperature starts to rise, ventilation takes place. This allows colder and drier external air to enter which reduces internal temperature and further reduces the humidity levels. This 'heat then vent' approach is very reliable but can be wasteful in energy terms.

More carefully chosen strategies can be just as effective without wasting energy. For example, it is often better during late spring and summer months to use a 'vent then heat' approach as the properties of the external air can control the humidity without resorting to excessive energy inputs.

5.3.7 Variable speed drives for pump and fan motors

The heat requirements of a greenhouse can vary greatly over a 24 hour period, leading to large differences in the quantities of hot water required in the greenhouse heating system. Using variable speed drives on motors enables pump output to be closely matched to the demand, thereby giving significant reductions in electricity consumption.

Similar principles can also be applied to fan motors.

6 Energy use benchmarks

Energy consumption kWh/m²	Edible crops				Ornamental crops			
	Intensive		Extensive		Intensive		Extensive	
	Heat	Electricity	Heat	Electricity	Heat	Electricity	Heat	Electricity
Best practice	520	10	225	8	350	60*	155	8
Typical	675	15	250	12	450	60*	175	12

Table 1 Energy use benchmarks

*Includes energy uses for supplementary and night-break lighting.

Please note: This table gives average values for the broad categories mentioned. For more specific benchmarks, the individual requirements of the specific crop and or variety must be considered. Examples of crops that fall into each category are as follows:

Edible crops

Intensive - tomato, cucumber, pepper, aubergine etc.

Extensive - lettuce etc.

Ornamental crops

Intensive - chrysanthemum (both pot & stem), begonia, poinsettia, young bedding plants, foliage plants etc.

Extensive - summer bedding plants, summer cut flowers, hardy nursery stock etc.

Specific guidance for an individual crop is available from Dutch data published in the 'Handboek Milieumaatregelen Glastuinbouw' (Handbook of Environmental Measures in Glasshouse Market Gardening), year 2000 edition. Appendix one gives targets for popular UK crops so that specific energy use benchmarks for each product can be determined. Appendix one also gives information on how the Dutch targets are calculated and determined.

6.1 Performance of energy saving measures

Environmental measure	Edible crops		Ornamental crops		Comments
	Int.	Ext.	Int.	Ext.	
1. Monitor energy use and set energy targets	1 - 5%	1 - 5%	1 - 5%	1 - 5%	Savings dependant on current management methods
2. Carry out regular maintenance and repairs	1 - 5%	1 - 5%	1 - 5%	1 - 5%	Savings dependant on current management methods
3. Monitor temperature distribution	2 - 5%	2 - 5%	2 - 5%	2 - 5%	Reduction in heating energy due to removal of temperature 'zones'
4. Better sealed greenhouse	3 - 8%	3 - 8%	3 - 8%	3 - 8%	Better savings with older greenhouse designs
5. Greenhouse insulation • Double glazed sidewalls • Plastic sheeting on sidewalls	 5% 3%	 5% 3%	 5% 3%	 5% 3%	
6. Thermal screens • Fixed screens • Movable screens	 12% 15%	 15% 25%	 *N/A 25%	 20% 30%	Reduction in yield may occur in intensive edibles due to light interception. R&D being carried out
7. Flue gas condenser	5 - 8%	5 - 8%	5 - 8%	5 - 8%	Only really practical with gas fired boilers due to corrosion problems
8. Insulation of heat dump tank	*N/A	*N/A	*N/A	*N/A	Calculations based on cost / benefit analysis of CO_2 enrichment. Dutch data claims 0.25% increase in production / kg CO_2
9. CHP • Electricity export off site • Electricity used on site (i.e. supplementary lighting)	Increase in heating fuel consumption likely due to efficiency of heat generation. All cases to be evaluated on a site by site basis and include consideration of value of exported electricity Savings due to removal of need to import electricity from grid connection All cases must be evaluated on site by site feasibility basis				
10. Temperature integration	5 - 10%	5 - 10%	5 - 10%	5 - 10%	Reduction in heating energy
11. Improved humidity control strategies	2 - 5%	-	2 - 5%	-	
12. Sparing use of minimum pipe settings	3 - 8%	-	3 - 8%	-	
13. Variable speed drives for pumps and fans	25%	25%	-	25%	

Table 2 Performance of the most popular energy saving measures used in protected horticulture

*N/A = not available

Source: Horticultural Development Council (HDC) and FEC Services Ltd.

Appendix one

Dutch energy saving targets

The horticultural industries in the Netherlands have published energy saving targets for all the crops that they grow. These targets are one part of a complete environmental covenant that also covers pesticide, nutrient and water use. All of the targets are published in the 'Handboek Milieumaatregelen Glastuinbouw' (Handbook of Environmental Measures in Glasshouse Market Gardening), year 2000 edition.

The targets in the handbook are given as **specific energy consumption** (SEC) and are expressed in units of GJ/Ha.

SEC can be calculated as:

$$\frac{\textbf{Primary energy use}}{\textbf{Greenhouse area}}$$

Calculating **primary energy use** involves converting all energy inputs to a common basis that makes allowance for the quantity of greenhouse gases released in the fuel conversion process. For example, the conversion factor for electricity considers the quantity of fuel consumed at the power station. This system is also used for calculating the SEC in the climate change levy (CCL) targets in the UK.

Fuel	Units	Conversion factor
Gas	kWh	1.00
	therms	29.31
Electricity (grid supplied)	kWh	2.60
Gas oil	litres	10.60
Heavy fuel oil	litres	11.40
Paraffin	litres	10.30
LPG	litres	7.04
Coal	tonnes	8600
Coke	tonnes	7750

Table 3 Conversion factors that can be used to convert delivered energy units to primary energy

Care must be taken, therefore, when comparing the figures with the **energy intensity** data given in this guide as energy intensity does not take primary energy use into consideration.

Target figures for example crops are given in Table 4a. For convenience, the figures have been converted to kWh/m^2 as these are the units of assessment commonly used in the UK.

Crop	Annual energy use kWh/m²										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Tomato	563	557	550	543	537	530	524	517	511	504	498
Cucumber	492	484	476	468	460	452	444	436	429	421	413
Pepper	453	446	439	432	425	418	410	404	397	390	383
Stem Mums	372	369	366	363	360	357	354	351	348	345	342
Pot Mums & Poinsettia	447	439	431	423	416	408	400	393	385	377	370
Alstromeria	296	288	280	273	265	258	250	242	235	227	220
Bedding plants	180	175	171	166	162	157	152	148	143	138	134
Lettuce	225	222	219	216	212	210	207	204	201	198	195

Table 4a - Dutch energy targets for popular UK crops expressed in units of kWh/m²

Technology	Annual energy use kWh/m²										
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Night break lighting	21	20	20	20	20	19	19	19	19	18	18
Supplementary lighting	160	156	152	147	143	139	135	130	126	122	118
Soil cooling	30	29	29	29	28	28	27	27	27	26	26
Other cooling	30	29	29	29	28	28	27	27	27	26	26

Table 4b - Dutch technology allowances expressed in kWh/m²

There are a number of refinements included in the Dutch system that a grower must consider when making his calculations:

Technology allowances

Firstly, a number of technology allowances are included which are given in the tables above. These let growers using some commonly used techniques add further energy use allowances to the basic target figures. The technologies are night break lighting, supplementary lighting, soil cooling and other cooling (e.g. produce refrigeration).

Therefore, if a stem chrysanthemum grower used supplementary lighting, his total target in 2002 was 366 + 152 = 518kWh/m².

CHP

Growers using CHP configured to export generated electricity only have to allocate 87% of the gas consumed by the CHP to nursery use. This method is a way of giving credit to the nursery for the value of the exported energy and only accounts for the heating energy that has been used on site.

Further reading

GPG323: 'Energy Saving Guide For Agriculture and Horticulture'

GPG376: 'A Strategic Approach to Energy and Environmental Management'

'The Calculation of Glasshouse Fuel Requirements Using Degree Day Data Corrected for Solar Gain', *Horticultural Development Council*

'Tomatoes: Guidelines for CO_2 Enrichment - A Grower Guide', *Horticultural Development Council*

ECA Scheme

The Enhanced Capital Allowance (ECA) scheme aims to encourage business to reduce carbon emissions through providing an incentive to invest in energy-efficient technologies. For further information visit the website at www.eca.gov.uk

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Free professional and impartial advice to help you cut your energy bills.

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For further information contact the Carbon Trust on **0800 58 57 94** or visit the web site at **www.thecarbontrust.co.uk/energy**

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A tomato growing facility

A typical greenhouse facility

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